Chromaticity[Ba1]

$$\xi_x = \frac{1}{4\pi}\int_0^L ds\left[\beta_x\left(K^2 - 2h^2 - 2K^2 h\eta_x - r\eta_x - h'\eta_x'\right) + \beta_x h\eta_x\left(h^2 - K^2\right) + \gamma_x h\eta_x\right],$$

$$\xi_y = \frac{1}{4\pi}\int_0^L ds\left[\beta_y\left(-K^2 + K^2 h\eta_x + r\eta_x + h'\eta_x'\right) + \gamma_y h\eta_x\right],$$

where $K^2 \equiv \frac{1}{(cp/e)}\frac{\partial B}{\partial x}$, $h \equiv \frac{1}{\rho(s)}$, and $r \equiv \frac{1}{(cp/e)}\frac{\partial^2 B}{\partial x^2}$.

Betatron Resonances[Br2]

Resonances in the particle's betatron motion occur when the tunes satisfy:

$$m\nu_x + n\nu_y = pN,$$

where m, n, p & N are integers, $|m| + |n|$ is the order of the resonance and

$$N \equiv \begin{cases} N_s & \text{structure resonances} \\ 1 & \text{non-structure resonances.} \end{cases}$$

Resonances are further classified as ‘regular’ or ‘skew’ depending on whether the resonance is driven by a regular or skew multipole. Sum resonances are of greater concern than difference resonances. The accompanying figure is a typical tune diagram indicating all regular multipole resonances up to order 4 assuming N = 1.

For a low emittance light source lattice the most important resonances are the third order regular sextupole driven resonances:

$$3\nu_x = pN \qquad \& \qquad \nu_x + 2\nu_y = qN\,.$$